49 Computerized Maintenance and Maintenance Management

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INTRODUCTION

Computerized maintenance refers to systems that utilize software to organize planning, scheduling, and support of maintenance and repair. It applies to the maintenance of complex systems that require periodic maintenance, such as reminding operators that preventive maintenance is due or even predicting when such maintenance should be performed based on recorded past experience.

Many organizations still view maintenance as a "cost center" but they are on the road to major problems with physical asset management. Historically, poor maintenance has resulted in failures in many organizations such as the airlines, refineries, shipping companies, and many others.

In process control and automation industries, instrumentation loops, control devices, sensors, and calibration equipment all are very important physical assets that control other physical assets. Effective use of computerized maintenance management system (CMMS) supports and enhances the maintenance and reliability of all physical assets. This can be only be done by installation and effective use of appropriate software supported by a correct management style.

COMPUTERIZED MAINTENANCE MANAGEMENT SYSTEMS

A CMMS software package maintains a computer database of information about an organization's maintenance operations. This information is intended to help maintenance workers do their jobs more effectively and to help management make informed decisions. The CMMS data may also be used to verify regulatory compliances.

There are many different commercially available CMMS software packages, most of which have the following functionalities:

1. Work-order management
2. Planning function
3. Scheduling function
4. Budget and cost control
5. Spares and inventory management
6. Key performance indicators
7. Preventive maintenance
8. Safety handling

A recent version of the CMMS is the condition-based monitoring (CBM), which is a form of proactive, preventive or predictive maintenance based on the condition of an asset. In CBM, the physical properties or trends of an asset is monitored on a periodically or continuously for attributes such as vibration, sound, temperature, lubricant condition, wear and tear, cracks, and so on. CBM is an alternative to failure-based maintenance initiated by breakdown of an asset. It is based on triggered information by the time passage or meter readings or likelihood of failures due to anomalies in operations.

Nowadays, many vendors offer web CMMS, which is an interactive online maintenance software program that takes advantage of the Internet. Web CMMS enables the tracking, scheduling, and management of maintenance for any purpose to a world-wide connection independent of where maintenance requirements or customers are located.

CMMS AS A MANAGEMENT TOOL

CMMS (also called enterprise asset management, EAM) is a critical foundational element necessary for the establishment of best practices in an organization. CMMS automates the standardized processes, collects historical information, and provides the ability to sort and analyze large amounts of data. This proactive tool when properly implemented and utilized provides accurate and timely data, enabling informed maintenance and operational management decisions.

CMMS/EAM is a very commonly used to support process industries, manufacturing, and many other businesses. CMMS is an essential information technology tool that filters the necessary information from large databanks for maintenance purposes and provides guidance to support effective physical asset management. The challenging process is the integration of maintenance data into CMMS (Figure 49.1) to help make the right decisions for the business.

Today's information technology for CMMS/EAM offers the maintenance leader an exceptional tool for managing the overall maintenance operation and maintenance processes as an internal business and a "profit center." However, maintenance surveys and benchmark evaluations conducted validate that poor utilization of existing CMMS systems creates a major improvement opportunity. The effective use of CMMS can improve:

- The product quality
- Utilization of equipment operators
- Equipment productivity and production throughput capacity
- Extend the equipment life and lower the life-cycle cost
- Improve productivity of the total operation and enhance profits

The results listed above can be achieved by maintenance organizations who have committed to continuous maintenance improvement, benchmarking, and best practices implementation as will be explained in this chapter.

CMMS Justification and Selection

CMMS has many capabilities such as: job scheduling, assigning personnel, reserving materials, recording costs, and tracking relevant information such as the cause of the problem, downtime, and recommendations for future action. In some cases, it schedules preventive maintenance automatically based on maintenance plans and/or meter readings. However, different software packages use different methods for reporting when a job should be performed.

An organization willing to install a new CMMS or upgrade an existing system should first justify the need for the system. The process to justify an effective package must be based upon the foundation that it is an investment that provides measurable benefits to maintenance and the total operation. The strategy to justify a CMMS must start with determining the true need for it and that there are benefits

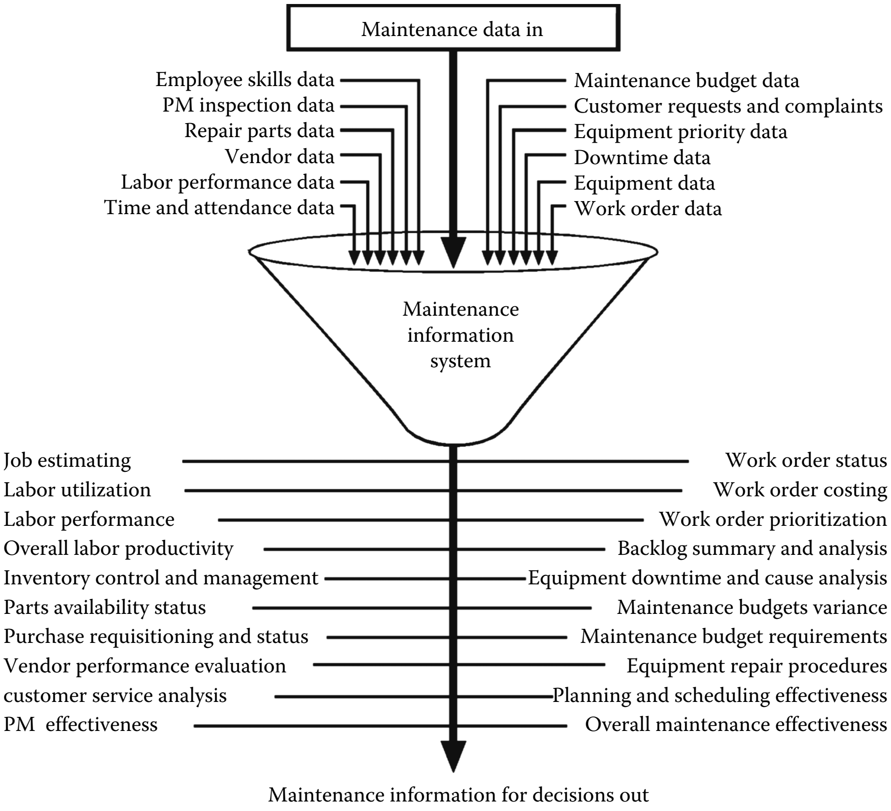
Maintenance data in
Employee skills data
PM inspection data
Repair parts data
Vendor data
Labor performance data
Time and attendance data
Maintenance budget data
Customer requests and complaints
Equipment priority data
Downtime data
Equipment data
Work order data
Maintenance information system
Job estimating
Labor utilization
Labor performance
Overall labor productivity
Inventory control and management
Parts availability status
Purchase requisitioning and status
Vendor performance evaluation
customer service analysis
PM effectiveness
Work order status
Work order costing
Work order prioritization
Backlog summary and analysis
Equipment downtime and cause analysis
Maintenance budgets variance
Maintenance budget requirements
Equipment repair procedures
Planning and scheduling effectiveness
Overall maintenance effectiveness
Maintenance information for decisions out

FIG. 49.1
Maintenance data in and effective CMMS for good information out.

to support economic justification of the investment. While the economic benefits provide the bottom line results for the investment, the overall justification strategy includes other key elements, such as

1. Determine the need for CMMS
2. Determine maintenance best practices
3. Evaluation and selection process
4. Determine the functional requirements
5. Best practice implementation
6. Total implementation
7. Benchmarking

The true need for CMMS can best be determined by conducting a total benchmark evaluation of the maintenance operations. This is the first step and very important because during this process the necessary best practices for the operation are determined.

The results of the total maintenance evaluation will highlight key best practice needs within the organization. There are many tools for this purpose one example is the scoreboard for maintenance excellence. A summary of results of an example scoreboard for maintenance excellence is shown in Table 49.1, which has 18 benchmark categories and 200 evaluation criteria.

In an organization, once the need for CMMS is justified, a very important step is the effective evaluation and selection of the software. Very closely linked to this evaluation and selection is the definition of CMMS functional requirements. With clearly defined functional requirements, it is possible to make valid comparisons between vendors, determine the vendor, and evaluate the overall cost of the software.

It is important to highlight that the evaluation and selection, and the implementation process should not fall on one department or a functional work group; as it covers a wide range of functional areas. Therefore, setting up a CMMS team and/or getting outside help when needed may be desirable.

The next step, "determining functional requirements," is actually a key part of overall evaluation before we begin the final selection. During this step, important functional areas are determined to assess the required capabilities. Examples of these functional areas are maintenance operations, the storeroom, maintenance repair operations (MRO), material management; purchasing, accounting, etc. and information systems determine what functional capabilities are needed in the CMMS.

Benchmarking

Benchmarking is an important phase in the CMMS selection and implementation. A typical benchmarking system will have a number of benchmark categories and many benchmark items that can be adaptable or specifically tailored to all systems and to their intended applications. Also, it provides a methodology for developing a benchmark rating of the existing CMMS to determine how well this tool is supporting best practices and the total maintenance process. It can also be used as a method to measure the future success and progress of a CMMS system implementation that is now being installed. Maintenance best practices are the key and

TABLE 49.1

Case Study for Maintenance Excellence

CAT	*Scoreboard for Maintenance Excellence Benchmark Category*	*Benchmark Items*	*Maximum Points by Category*	*Actual Benchmark Points by Category*
A	Maintenance and organization culture	10	100	17
B	Organization and administration	12	120	48
C	Work authorization and work control	10	100	8
D	Budget and cost control	11	110	9
E	Maintenance planning and scheduling	12	120	3
F	Maintenance storeroom	16	160	7
G	Preventive and predictive maintenance	22	220	35
H	Lubrication program	11	110	25
I	Overall equipment effectiveness (OEE)	9	90	2
J	Operator-based maintenance	8	80	15
K	Engineering support	9	90	43
L	Safety, housekeeping and regulatory compliance	12	120	62
M	Craft skills development	9	90	2
N	Maintenance performance measurement	9	90	10
O	Maintenance supervision/leadership	6	60	16
P	CMMS	13	130	10
Q	Maintenance facilities, equipment and tools	7	70	59
R	Continuous maintenance improvement	14	140	32
	Total baseline benchmark points		2000	403
			21% of total possible points	

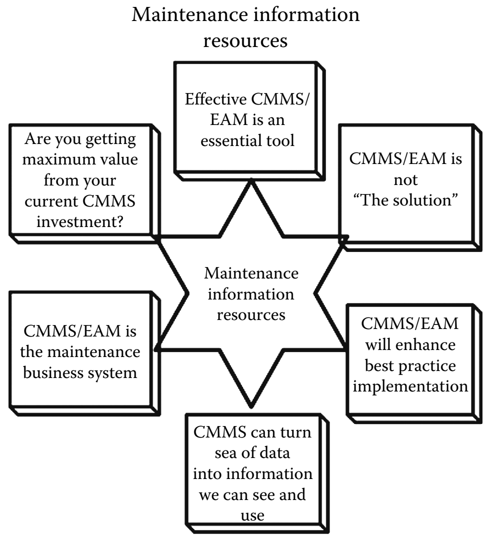
Maintenance information resources
Effective CMMS/ EAM is an essential tool
Are you getting maximum value from your current CMMS investment?
CMMS/EAM is not "The solution"
Maintenance information resources
CMMS/EAM is the maintenance business system
CMMS/EAM will enhance best practice implementation
CMMS can turn sea of data into information we can see and use

FIG. 49.2
Effective CMMS is a key to continuous reliability improvement.

the CMMS is the information technology tool that links it all together. Maintenance information is one of the key resources (Figure 49.2) and must be a part of the approach to continuous reliability improvement which covers maintenance resources as shown in Figure 49.2.

An example of the CMMS benchmarking system is shown in Table 49.2. This particular benchmarking has nine assessment categories and 50 benchmark items associated with these categories. The CMMS benchmarking system rating scale is shown in Table 49.3.

TABLE 49.2
Summary of the CMMS Benchmarking System

CMMS Benchmark Categories	*Benchmark Items*
1. Data integrity	6
2. Education and training	4
3. Work control	5
4. Budget and cost control	5
5. Planning and scheduling	7
6. MRO materials management	7
7. Preventive and predictive maintenance	6
8. Maintenance performance measurement	4
9. Other uses of CMMS	6
Total benchmark items	50

TABLE 49.3
CMMS Benchmarking System Rating Scale

Class A	180–200 points (90% +)
Class B	140–179 points (70%–89%)
Class C	100–139 points (50%–69%)
Class D	0–99 points (up to 49%)

TABLE 49.4
Sample of the CMMS Benchmarking System

CMMS Benchmarking Categories and Item Descriptions	*Yes (4)*	*No (0)*	*Working on It (1, 2 or 3)*
A. CMMS Data Integrity			
Equipment (asset) history data complete and accuracy 95% or better			
Spare parts inventory master record accuracy 95% or better			

The CMMS benchmark evaluation can be conducted internally by the maintenance leader or via an internal team effort of knowledgeable maintenance people. Other options include using support from an independent resource to provide an objective maintenance benchmarking resource. The CMMS benchmarking system provides a means to evaluate and classify the current installation as either "Class A, B, C, or D" as in Table 49.3. Each benchmark item that is rated as being accomplished satisfactorily receives a maximum score of 4 points. If an area is currently being "worked on" a score of 1, 2, or 3 points can be assigned based on the level of progress achieved. For example, if spare parts inventory accuracy is at 92% compared to the target of 95%, a score of 3 point is given. A maximum of 200 points is possible. A benchmark rating of "Class A" is within the 180–200 point range. A sample is shown in Table 49.4.

CMMS IMPLEMENTATION

Developing a "Class A" CMMS installation requires that the organization start early in the implementation phase with establishing how they will determine the overall success of this installation. The benchmarking system provides the framework for internal benchmarking of the installation as it matures. Establishing a "Class A" CMMS requires that a number of key databases be established and that a number of maintenance best practices be in place. Data integrity, accuracy, and continuous maintenance of the key databases provide the foundation for a "Class A" installation. There are a number of other factors related to the CMMS and to maintenance best practices that in combination produce a future "Class A" installation.

Typical major categories of CMMS benchmarking system that are listed in Table 49.2 will be explained next.

CMMS Data Integrity

The data integrity will have the following benchmark items:

1. Accuracy of equipment history database
2. Accuracy of spare parts database
3. Bill of materials
4. PM tasks/frequencies

5. Maintaining parts database
6. Maintaining equipment database

Accuracy of Equipment History Database The equipment database represents one of the essential databases that must be developed or updated as part of implementing a new CMMS. It requires that a complete review of all equipment be made to include all parent/child systems and subsystems that will be tracked for costs, repairs performed, etc. The work to develop or update this database should begin as soon as possible after the data structure of the equipment master file for the new CMMS is known.

The equipment master information for a piece of equipment (parent/child), manufacturer, serial number, equipment specs, and location will all need to be established. If the installation and removal of components within certain process type operations requires tracking by serial number and compliance to process safety management requirements these equipment items will have to be designated in the equipment database.

If an equipment database exists as part of an old CMMS, now is the time to review the accuracy of the old equipment database prior to conversion to the new system. Conversion of the new equipment master database into the new system should be done only after a thorough and complete update of the old database has occurred. Once the new equipment master database has been converted to the new CMMS a process to maintain it at an accuracy level of 95% or above should be established.

Accuracy of Spare Parts Database The spare parts database represents another key database that must be developed or updated as part of implementing a new CMMS. For operations not having a parts inventory system this will require doing a complete physical inventory of spare parts and materials. All inventory master record data for each item will need to be developed based on the inventory master record structure for the new CMMS and loaded directly to the inventory module.

Operations that have an existing spare parts database should take the time to do a complete review of it prior to conversion. Typically, this will allow for purging the database of obsolete parts and doing a complete review of the inventory master record data. This can be a very time consuming process, but it allows the operation an excellence chance to finally take the time to revise part descriptions, review safety stock levels, reorder points and vendor data, and start the new CMMS with an accurate parts inventory database.

Bill of Materials One key functional capability of CMMS is to provide a spare parts listing (bill of materials) within the equipment module. This requires researching where spare parts are used and linking inventory records with equipment master records that are component parts of an equipment asset. This function would also add, change, or delete items from an established spares list or copy a spares list to another equipment master record. Also, this feature would copy all or part of a spares list to a work-order job plan and create a parts requisition or pick list to the storeroom.

The process of establishing a spares list is time consuming and would involve only major spares that are currently carried in stock. Most CMMS systems have the capability to build the spare parts list as items are issued to or purchased for a piece of equipment. It is recommended that equipment bill of materials be established but the conversion of equipment master data can take place without this information being available. Because bill of materials for spare parts is so beneficial for planning purposes, it is recommended that the process to identify key spares in the equipment master be a priority area.

Preventive Maintenance Tasks/Frequencies The preventive and predictive maintenance (PM/PdM) database is another key database necessary for establishing a "Class A" installation. If a current PM/PdM database is present, it is recommended that the existing procedures be reviewed and updated prior to conversion to the new system. If the existing PM/PdM database has been updated continuously on the old system, conversion can probably occur directly from the old to the new PM/PdM database this; however, will depend on the PM/PdM database structure of the new system.

It is recommended that in the very early stages of a new CMMS benchmark/selection process that the status of the current PM/PdM program be evaluated. If a process for the review/update of PM/PdM procedures has not been in place, then it is very important to get something started as soon as possible. This provides an excellent opportunity to establish a team of experienced craft people, engineers, and maintenance supervisors to work on PM/PdM procedures to review and update task descriptions, frequencies, and making sure that all equipment is covered by proper procedures.

Maintaining Parts Database After having installed a CMMS, it is highly recommended that one person should be assigned direct responsibility for maintaining the parts database. This person would have responsibility for making all additions and deletions to inventory master records, changing stock levels, reorder points and safety stock levels, and changing any data contained in the inventory master records. This person could also be designated responsibility for coordinating the development of the spares list if this information is not available. He/she would be responsible for recommending obsolete items based on monitoring of usage rates or due to equipment being removed from the operation. The practice of having one primary person assigned direct responsibility for the inventory master records can help ensure that parts database accuracy is 95% or greater.

Maintaining Equipment Database One person should be appointed for managing this database. He/she person should be responsible for making all changes to equipment master records. Information on new equipment needs to come to this person for setting up parent/child relationships of components in the equipment master records. Information on equipment being removed from the operation should also come to him/her to delete equipment from the master records. Coordination between this person and the person responsible for the parts database is necessary to ensure that obsolete parts were identified and/or removed from the inventory system due to removal of equipment.

CMMS Education and Training

The education and training will have the following benchmark items:

1. Initial training
2. Ongoing training
3. Initial training for operations personnel
4. CMMS systems administrator/backup trained

Initial Training One of biggest roadblocks to an effective CMMS installation is the lack of initial training on the use of the system. Many organizations never take the time up front to properly train their people on their system. Shop-level people must gain confidence in using the system for reporting work-order information and knowing how to look up parts information. The CMMS implementation plan should include an adequate level of actual hands-on training on the system for all maintenance employees prior to the "go live" date. It is important to invest the time and expense to "train the trainers" who can in turn can assist with the training back in the shop. Many organizations set up "conference room pilots" where the CMMS software is set up and training occurs with actual data using CMMS vendor trainers or in house trainers. It is highly recommended that competency based training be conducted so that each person trained can demonstrate competency in each function they must perform on the system.

Ongoing Training The CMMS implementation plan must consider having an ongoing training program for maintenance and storeroom personnel. After the initial training, there must be someone in the organization with the responsibility for ongoing training. If a good "trainer" has been developed within the organization prior to the "go live" date, then this person can be the key to future internal training on the new system. Ongoing training can include one on one support that helps to follow up on the initial training.

Initial Training for Operations Personnel The customers of maintenance must gain basic understanding of the system and know how to request work, check status of work requested, and understand the priority system. During implementation, operations personnel need to get an overview of how the total system will work and the specific things they will need to do to request work. If the organization has a formal planning and scheduling process, they will also need to know the internal procedures on how this will work.

CMMS Systems Administrator/Backup Trained It is important that each site have one person trained and dedicated as the systems administrator with a backup trained whenever possible. Typically, this person will be from information services and have a complete knowledge of system software, hardware, database structures, interfaces with other systems, and report writing capabilities. The systems administrator will also have responsibility for direct contact with the CMMS vendor for debugging software problems and for coordinating software upgrades.

Work Control

The Work Control has the following benchmark items:

1. Work control function established
2. On-line work request based on priorities
3. Work-order system accounts for 100% of craft hours
4. Backlog reports
5. Priority system

Work Control Function Established A well-defined process for requesting work, planning, scheduling, assigning work, and closing work orders should be established. The work control function will depend on the size of the maintenance operation. Work control may involve calls coming directly to a dispatcher who creates the work-order entry and forwards the work order to a supervisor for assignment. The work request could also be forwarded directly to an available crafts person by the dispatcher for execution of true emergency work.

Work control can also be where work requests are forwarded manually or electronically to a planner who goes through a formal planning process for determining scope of work, craft requirements, and parts requirements to develop a schedule. PM/PdM work would be generated and integrated into the scheduling process. The status of the work order would be monitored which might be in progress, awaiting parts, awaiting equipment, awaiting craft assignment, or awaiting engineering support. A work-order backlog would also be maintained to provide a clear picture of work-order status.

Effective work control provides systematic control of all incoming work through to the actual closing of the work order. The work control process should be documented with clearly defined written procedures unique to each maintenance operation.

Online Work Request Based on Priorities Requesting work online represents an advanced CMMS functional capability where the customer enters the work request directly into the system on a local area network or via e-mail. Online work requests would include basic information about work required, equipment location, date work to be completed by, name of requestor, and priority of the work. This information would go to the work control function where the jobs would be planned, scheduled, and assigned based on the overall workload. The requestor would have the capability to track the status of their jobs online and even give final approval that the work was completed satisfactorily.

Work-Order System Accounts for 100% of Craft Hours All craft work should be charged to a work order of some type. Accountability of labor resources is an important part of managing maintenance as an internal business. Quick reporting to standing work orders can be established for jobs of short duration within a department or for the reporting of non-craft time such as meetings, delays in getting the equipment to work on, training, and chasing parts.

Backlog reports: Maintaining good control of the work to be done is essential to the maintenance process. Having the capability to visually see the backlog helps to effectively plan and schedule craft resources.

Priority system: A "Class A" CMMS installation will have in place a priority system that allows for the most critical repairs to get done first. An effective priority system adds professionalism to the maintenance operation and directly supports effective planning and scheduling. There are two basic systems for establishing priorities:

- Straight Numeric—Priority 1, 2, 3, 4, 5, etc. where each priority level is defined by a definition such as Priority 1: A true emergency repair that affects safety, health, or environmental issues.
- RIME System—This system combines the criticality index of the equipment (10 highest to 1 lowest) with criticality of the work type (10 highest to 1 lowest) to compute the RIME priority number. The RIME priority number equals the equipment criticality index multiplied by the criticality number of the work type.

Budget and Cost Control

Budget and cost control have the following benchmark items:

1. Craft labor, parts, and vendor support costs
2. Budget status-operating departments
3. Cost improvements due to CMMS
4. Deferred maintenance identified
5. Life-cycle costing supported

Craft Labor, Parts, and Vendor Support Costs The equipment history file should provide the source of all costs charged to the asset. Here, it is important to ensure that all labor is charged to the work orders for each asset and that parts are charged to the respective work orders.

Budget Status-Operating Departments Operating departments should be held accountable for their respective maintenance budgets. With an effective work-order system in place for charging of all maintenance costs, the accounting process should allow for monitoring the status of departmental budgets. One recommended practice is for maintenance to be established as a zero-based budget operation and that all labor and parts be charged back to the internal customer. This practice helps ensure accountability for all craft time, parts, and materials to work orders.

Cost Improvements due to CMMS The impact of a successful CMMS installation should be reduced costs and gained value in terms of greater output from existing resources. The CMMS team should be held accountable for documenting the savings that are achieved from the new CMMS and the maintenance best practices that evolve. The areas that were used to justify the capital investment such as reduced parts inventory, increased uptime, and increased craft productivity should all be documented to show that improvements did occur.

Deferred Maintenance Identified It is important that maintenance provides management with a clear picture of maintenance requirements that require funding for the annual budget. Deferred maintenance on critical assets can lead to excessive total costs and unexpected failures. Benefits from CMMS will provide improved capability to document deferred maintenance that must be given priority during the budgeting process each year.

Life-Cycle Costing Supported Complete equipment repair history provides the base for making better replacement decisions. Many organizations often fail to have access to accurate equipment repair costs to support effective replacement decisions and continue to operate and maintain equipment beyond its economically useful life. As a result, the capital justification process then lacks the necessary life-cycle costing information to support replacement decisions.

Planning and Scheduling

Planning and scheduling have the following benchmark items:

1. Planning and scheduling
2. Planned work increasing
3. Craft utilization measured and improving
4. Work schedules available
5. Spare parts status is available
6. Scheduling coordination with operations
7. True emergency repairs tracked

Planning and Scheduling This maintenance best practice area is essential to better customer service to the operations and greater utilization of craft resources. For most maintenance operations with 25–30 crafts people, a fulltime planner can be justified. The CMMS system functionality must support the planning process for control of work orders, backlog reporting, status of work orders, parts status, and craft labor availability. The planning and scheduling function supports changing from a "run to failure strategy" to one for proactive, planned maintenance.

Planned Work Increasing The bottom line results for the planning process is to actually increase the level of the planned work. Percent planned work should be monitored and included as one of the overall maintenance performance metrics. In some organizations with effective PM/PdM programs, the level of planned work can be in the 90% range or more.

Craft Utilization Measured and Improving Effective planning and scheduling is essential to increasing the levels of actual hands-on wrench time of the craft work force. Improving craft utilization allows more work to get done with current staff by eliminating non-craft activities such as waiting for equipment, searching for parts, and scheduling the right sequence for different crafts on the job.

Work Schedules Available One key responsibility of the planning process is to establish realistic work schedules for bringing together the right type craft resources, the parts required, the equipment to be repaired, or serviced along with having the time available to complete the job right the first time. The actual schedule may only start with a one day schedule and gradually work up to scheduling longer periods of time. Work schedules provide a very important customer service link with operations that helps to improve overall coordination between maintenance and operations.

Spare Parts Status Is Available One of the most essential areas to support effective planning is the maintenance storeroom and the accuracy of the parts inventory management system. Jobs should not be put on the schedule without parts being on hand. The planner must have complete visibility of inventory on hand balances, parts on order, and the capability to reserve parts for planned work.

Scheduling Coordination with Operations As the planning function develops, there will be improved coordination with operations to develop and agree upon work schedules. This may involve coordination meetings near the end of each week to plan weekend work or to schedule major jobs for the upcoming week. Direct coordination with operations allows maintenance to review PM/PdM schedules or to review jobs where parts are available to allow the job to scheduled based on operations scheduling equipment availability.

True Emergency Repairs Tracked Many organizations really focus on reducing true emergency repairs, which create uncertainty for operations scheduling and contribute to significantly higher total repair costs than planned work. Improved reporting capabilities of an effective CMMS will allow for better tracking of emergency repairs, document causes for failures and assist in the elimination of the root causes for failures.

MRO Materials Management

Materials management has the following benchmark items:

1. MRO materials management
2. Inventory management module
3. Inventory cycle counting established
4. Parts kiting
5. Electronic parts requisitioning
6. Critical spares identified
7. Reorder notification process
8. Warranty information

MRO Materials Management The overall area of MRO parts and materials procurement, storage, inventory management, and issues represents another best practice area that often needs major work when implementing a CMMS and developing a "Class A" installation. Many organizations never take the time to set up a well-planned and controlled storeroom operation and often find out that their parts database is a weak link needing major updates before it can truly be used effectively.

Inventory Management Module The work-order module must be fully integrated with an accurate parts inventory management module to charge parts back to work orders, to check parts availability status for planned work, to reserve parts, and to check status of direct purchases. A "Class A" CMMS installation will develop, maintain, and fully utilize the inventory module and ensure that it is fully integrated with the work-order module.

Inventory Cycle Counting Established Inventory accuracy should be one of the key metrics for MRO materials management and it can best be accomplished by cycle counting rather than annual physical inventories. Most CMMS systems will allow for special criteria to be developed such as doing an ABC analysis of inventory items (based on either usage value or frequency of issue) and then scheduling of periodic counts for each classification of inventory item for cycle count. For example, A items would be counted more frequently than B and C items. The real value of cycle counting is that it is a continuous process that creates a high level of discipline and allows for inventory problems and adjustment to be made throughout the year rather than once following the annual inventory.

Parts Kiting This best practice area is key to the planning process and can evolve over time as the planning process matures to the point of being able to give the storeroom prior notification on the parts required for planned jobs. Controlled staging areas are set for parts that are either pulled from stock or received from direct purchases.

Electronic Parts Requisitioning This functional capability can provide paperless work flow for requisitioning of parts directly from maintenance to the storeroom for creation of a pick list for the item or go to purchasing to create a purchase order for a stock item or direct purchase. In some cases, electronic requisitioning might go directly to the vendor using e-commerce capability.

Critical Spares Identified Critical spares (or insurance items) that may be a one of a kind, high-cost spare are often important element of the parts inventory system. It is recommended that these items be classified and identified in the item master record as such. This practice will help to separate these items from the regular inventory management process and identify them as a separate part of the total inventory value that has been fixed. Critical spares should also be identified in the spares list for the equipment they have been purchased for.

Reorder Notification Process The capability to determine when and what to reorder based on a review of stock level reorder points is an important feature for a "Class A" installation. A recommended reorder report should be generated periodically and reviewed for validity as well as for any future needs that may not be reflected in current on hand balances. Based on final review of the recommended reorder report, electronic requisitioning then could occur directly to purchasing.

Warranty Information Many organizations fail to have a process in place to track warranty information and in turn incur added costs by not being able to get proper credit for items under warranty. Tracking specific high-value parts or components and specific equipment under warranty should be a CMMS functionality of the equipment master or the inventory item master database. The system should provide a quick reference and alert to the fact that the item is still under warranty and that a follow-up claim to the vendor is needed.

Preventive and Predictive Maintenance

PM/PdM has the following benchmark items:

1. PM/PdM change process
2. PM/PdM compliance is measured
3. Long-range PM/PdM scheduling
4. Lubrication services
5. CMMS captures reliability data
6. Complete PM/PDM task descriptions

PM/PdM Change Process This best practice area simply ensures that PM/PdM procedures are subject to a continuous review process and that all changes to the program are made in a timely manner. The CMMS system should provide an easy method to update task descriptions and task frequencies and allow for mass updating when the procedure applies to more than one piece of equipment.

PM/PdM Compliance Is Measured One key measure of overall maintenance performance should be how well the PM/PdM program is being executed based on the schedule. Measuring PM/PdM compliance ensures accountability from maintenance and from operations. Normally, a scheduling window of a week will be established to determine compliance. A goal of 98% or better for PM/PdM Compliance should be expected.

Long-Range PM/PdM Scheduling As a PM/PdM schedule is loaded to the system, peaks and valleys may occur for the actual scheduling due to frequencies of tasks requiring attention at the same time period. The CMMS system should provide the capability to level load the actual PM/PdM schedule and to view upcoming PM/PdM workloads to assist in the overall planning process.

Lubrication Services Ideally lubrication services, tasks, frequencies, and specifications should be included as part of the PM/PdM module. A continuous change process for this area should also be put in place as well as an audit process established to ensure all lube and PM/PdM tasks are being performed as scheduled.

CMMS Captures Reliability Data The elimination of root causes of problems is the goal rather than just more PM/PDM. One important feature of a "Class A" installation is being able to capture failure information that can in turn be used for reliability improvement. This requires that a good coding system for defining causes for failures be developed and that this information be accurately entered as the work order is closed.

Complete PM/PDM Task Descriptions PM/PdM task descriptions often provide vague terminology to check, adjust, inspect, etc. and do not provide clear direction for specifically what is to be done. Task descriptions should be reviewed periodically and details added that to the level that a new crafts person would understand exactly what is to be done and be able to adequately perform the stated task.

Maintenance Performance Measurement

Maintenance performance measurement has the following benchmark items:

1. Equipment downtime reduction
2. Craft performance
3. Maintenance customer service
4. Maintenance performance measurement process

Equipment Downtime Reduction Another key metric for measuring overall maintenance performance is increased equipment uptime. The improvement in this metric is a combination of many of the previously mentioned best practices all coming together for improved reliability. Downtime due to maintenance should be tracked and positive improvement trends should be occurring within a "Class A" installation.

Craft Performance Two key areas affecting overall craft productivity are craft utilization (wrench time) and craft performance. Measurement of craft performance requires that realistic planning times be established for repair work and PM tasks. A standard job plan database can be developed for defining job scope, sequence of tasks, special tools listing, and estimated times. The goal is measurement of the overall craft work force and not individual performance. Planning times are also an essential part of the planning process for developing a more accurate picture of workload and to support scheduling of overtime and staff additions.

Maintenance Customer Service The results of improved maintenance planning must be improved customer service. The overall measurement process should include metrics such as compliance to meeting established schedules and jobs actually completed on schedule.

Maintenance Performance Measurement Process In this area, it is important to have a performance measurement process that includes a number of key metric in each of the following major categories:

- Budget and cost
- Craft productivity
- Equipment uptime
- Planning and scheduling
- Customer service
- MRO materials management
- PM/PdM

The overall maintenance performance process should be established so that it clearly validates the benefits being received from the CMMS and maintenance best practice implementation.

OTHER USES OF CMMS

Other uses of CMMS include the following benchmark items:

1. Maintenance managed as a business
2. Operations understands benefits
3. Engineering changes
4. Equipment database structure
5. Failure and repair codes
6. Maintenance standard task database

Maintenance Managed as a Business One true indicator for a successful CMMS installation is that it has changed the way that maintenance views it role in the organization. It should progress to the point that maintenance is viewed and managed as an internal business. This view requires greater accountability for labor and parts costs, greater concern for customer service, better planning, and greater attention to reliability improvement and increased concern for the maintenance contribution to the bottom line.

Operations Understands Benefits There is direct evidence that operations understands that an improved CMMS is a contributor to improve customer service. The scheduling process is continuously improving through better coordination and cooperation between maintenance and operations within a "Class A" installation.

Engineering Changes Accurate engineering drawings are essential to maintenance planning and to actually making the repairs. Asset documentation must be kept up to date based on a formal engineering change process. Feedback to engineering must be made on all changes as they occur on the shop floor. Engineering must in turn ensure that master drawings are updated and that current revisions made available to maintenance.

Equipment Database Structure To provide equipment history information in a logical parent/child relationship, the equipment database structure has been developed using an identification of systems and subsystems. Accessing the equipment database should allow for drilldown from a parent level to lower level child locations that are significant enough for equipment master information to be maintained.

Failure and Repair Codes The reporting capability of the CMMS should provide good failure trending and support analysis of the failure information that is entered from completed work orders. Improving reliability requires good information that helps to pinpoint root causes of failure.

Maintenance Standard Task Database Developing the maintenance standard task database (or standard repair procedures) for recurring jobs is an important part of a planner's job function. This allows for determining scope of work, special tools and equipment, and for estimating repair times. Once a standard repair procedure is established, it can then be used as a template for other similar jobs resulting in less time for developing additional repair procedures.

BENEFITS OF CMMS

Surveys consistently show that most CMMS systems are not used to their full capacity. Often CMMS is viewed as "the solution." It is an important part but today's best practices for reliability and maintenance are essential to the bottom line results. With an effective CMMS the following benefits can be expected:

1. *Improved work control:* Better work management with improved control of work requests by craft, monitoring of backlogs, determining priorities, and

scheduling decisions for overtime effectively. Full accountability of craft time/labor cost to work orders, which accrues to asset history and ensures charge backs to customers/tenants.

2. *Improved planning and scheduling:* The systems and procedures to establish a more effective day-to-day maintenance planning and scheduling process contribute to improved craft labor utilization and customer service. Better planning and scheduling with customers is an important benefit. This must be planned for maintenance excellence because it does not occur naturally.
3. *Enhanced PM/PdM:* Automatic scheduling of repetitive PM activities with PM tasks and inspection frequencies documented on the PM module and printed as part of the PM work order. CMMS enhances PM by providing a method to monitor failure trends and to highlight major causes of equipment breakdowns and unscheduled repairs.
4. *Improved parts and materials availability:* Well-organized stockrooms with accurate inventory records, a stock locator system, accurate stock levels, and a storeroom catalog can significantly improve the overall maintenance operation. Having the right part at the right time is the key to effective maintenance planning, increased maintenance customer service, and reduced downtime.
5. *Improved MRO materials management:* The means for more effective management and control of maintenance parts and material inventories. Information for decisions on inventory reduction is readily available to identify parts usage, excess inventory levels, and obsolete parts.
6. *Improved reliability analysis:* The means to track work order and equipment history data related to types of repairs, frequencies, and causes for failure. It allows maintenance to have key information on failure trends that leads to eliminating root causes of failures and to improving overall equipment reliability.
7. *Increased budget accountability:* Provides for greater accountability for craft labor and parts/materials through the work order and storeroom inventory modules. Increased level of control, greater visibility and accountability of the overall maintenance budget by individual piece of equipment and by using department or work order. Replacement and renovation decisions for facilities and other building systems can be supported by cost information from the CMMS.
8. *Increased capability to measure performance and service:* A good source of maintenance information to allow more effective measurement of maintenance performance and service to provide measurement of improvements in areas such as craft labor productivity, PM compliance, downtime, store inventory control, backlog, level of maintenance, service, reliability, etc.
9. *Increased level of maintenance information:* A major benefit comes from developing the historical database that becomes readily available as critical maintenance information. An effective CMMS helps turn data into information you can use to manage maintenance as an internal business.

SUMMARY

Developing a "Class A" CMMS installation requires the combination good system functionality and improved maintenance practices. The CMMS Team should begin very early during implementation with how it will measure the success of the installation. The recommendations provided here for using the CMMS benchmarking system can help your organization achieve maximum return on its investment.

Bibliography

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